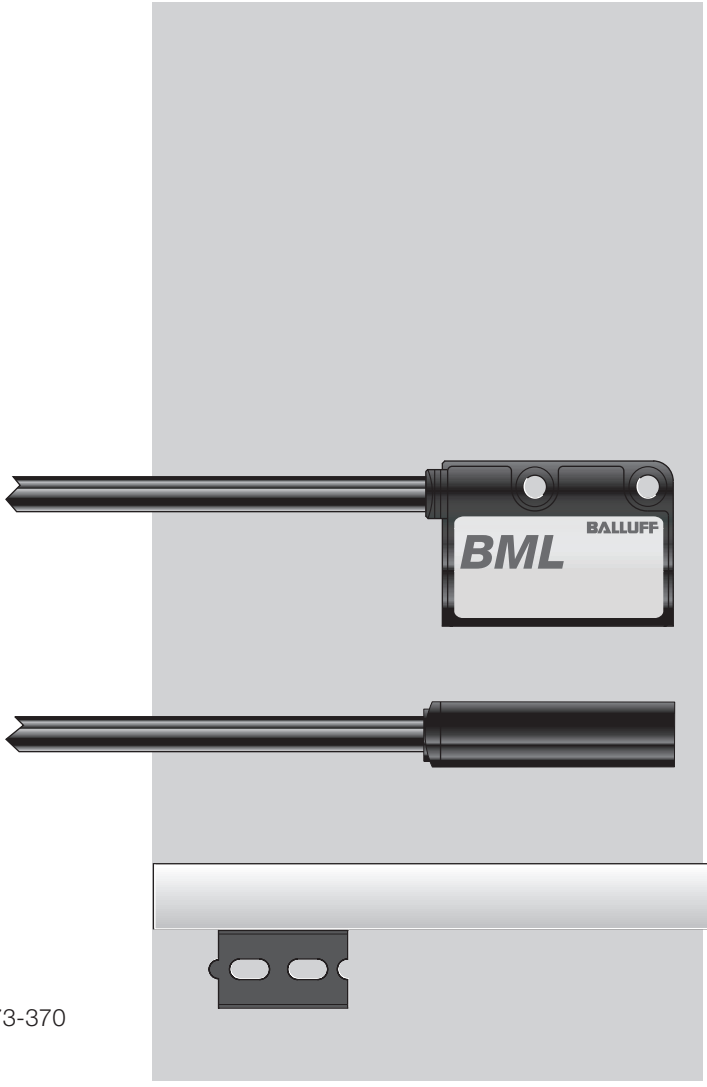
BALLUFF

sensors worldwide

BML-S1B0-Q_ _ _-M_ _ _-_0-KA_ _
BML-S1E0-Q_ _ _-M_ _ _-_0-KA_ _

english User's Guide



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1 Safety Advisories

Read this manual before installing the sensor and placing it in operation.

1.1 Intended use

The BML displacement sensor is fitted into a machine or piece of equipment for its application. Together with a controller (PLC) it comprises a displacement measurement system and may be used only for this purpose.

Unauthorized modifications and non-allowed use will result in loss of guarantee and warranty.

1.2 Qualified personnel

This manual is intended for technical personnel who are involved in installation and setup.

1.3 Use and testing

Prevailing safety regulations and codes must be observed for using the displacement sensor.

In particular, measures must be taken to ensure that a defect in the displacement sensor will not result in hazards to persons or equipment. This includes installation of additional safety limit switches, emergency stop switches, and the maintaining of permissible ambient conditions. BML displacement sensors may not be used in life-saving systems, in aircraft, etc.

1.4 Validity

This Guide is valid for displacement sensors models
BML-S1B0-Q-...-KA_ _ and
BML-S1E0-Q-...-KA_ _

An overview of the various versions can be found in section 12 "Versions" (refer to part label).

The CE Mark verifies that our products meet the requirements of EC Directive

89/336/EEC (EMC Directive)

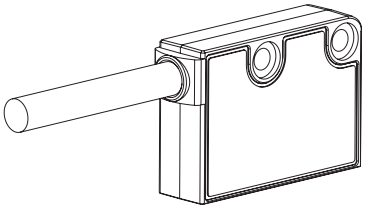
and the EMC Law. Testing in our EMC Laboratory, which is accredited by DATech for Testing Electromagnetic Compatibility, has confirmed that Balluff products meet the EMC requirements of the following Generic Standards:

EN 61000-6-4 (emission)

EN 61000-6-2 (noise immunity)

Emission tests:
RF Emission
EN 55011 Group 1, Class A+B
Noise immunity tests:
Static electricity (ESD)
EN 61000-4-2 Severity level 3
Electromagnetic fields (RFI)
EN 61000-4-3 Severity level 3
Fast transients (Burst)
EN 61000-4-4 Severity level 3
Surge
EN 61000-4-5 Severity level 2
Line-induced noise induced by high-frequency fields
EN 61000-4-6 Severity level 3
Magnetic fields
EN 61000-4-8 Severity level 4

2 Functional variants of the displacement sensor



The BML is a non-contact, incremental displacement feedback system consisting of a sensor head and a magnetic tape. The system is available in several variants: with position signal function only, with additional reference point function and/or with limit switch function. All functions are implemented by means of magnetic sensing. The reference position is integrated in the tape, and limit switch magnets can be attached at any desired position.

The following table show the functional variants with their possibilities.

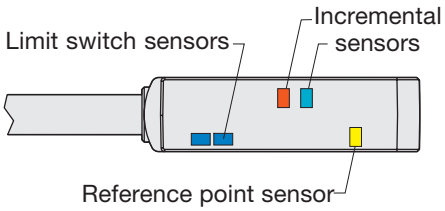
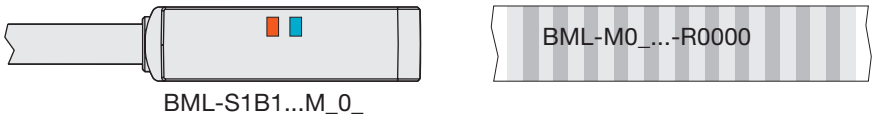


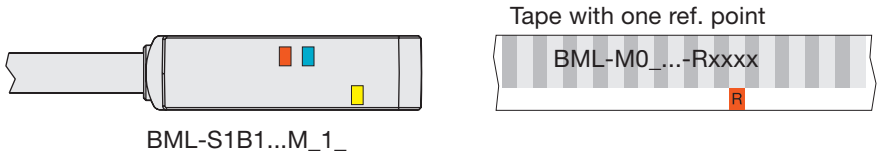
Fig. 2-1: Sensor head configuration

Output signal	A-Signal B-Signal
Reference signal	none Single signal Pole-periodic Fixed periodic
Limit switch	 Front and rear

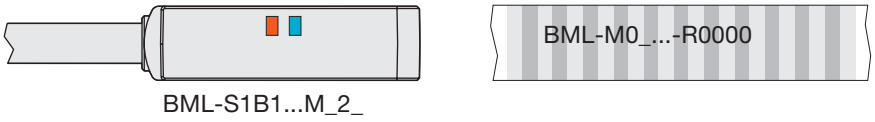
System variant 1:
No reference point signal



System variant 2:
One reference point signal



System variant 3:
Pole-periodic reference point signals



System variant 4:
Fixed periodic reference point signals

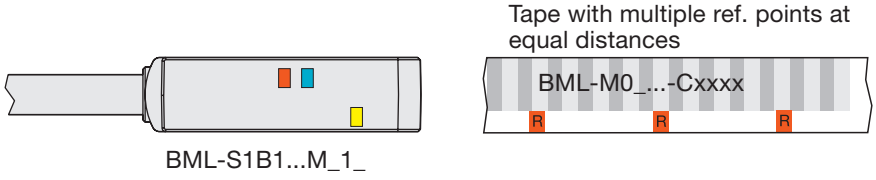


Fig. 2-2: Length measurement systems

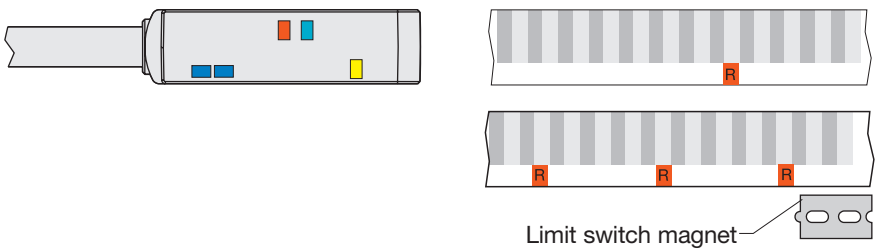


Fig. 2-3: Length measurement system with limit switch sensors, tape with reference points and limit switch magnets

Note:

For a detailed technical description and installation instructions for tapes, see User's Guide for tape at www.balluff.de

3 Function and Characteristics

3.1 Characteristics

BML displacement sensors are characterized by:

- High system accuracy of 50 µm
- High resolution of up to 5 µm
- High traverse speed of up to 20 m/s
- Position signal in real-time
- Insensitive to shock, vibration, and contamination such as dust and oil
- Wear- and maintenance-free
- Rugged
- Enclosure rating IP 67 per IEC 60529

3.2 Principle of operation

The sensing head is attached to the machine member whose position is to be determined, while the magnetic tape is mounted along the direction of travel. The tape contains alternating magnetic north- and south poles.

The two incremental sensors in the sensing head measure the magnetic alternating field.

As the sensing head travels over the tape the two incremental sensors pick up the magnetic periods so that the controller can determine the distance traveled.

3.3 Interface signals

The sensing head can convert the sinusoidal and cosinusoidal signals either into A/B pulses and send them to the controller (RS422). The digital A/B pulses are interpolated in the sensing head.

The two digital pulses A and B are 90° phase-shifted, with the sign of the phase shift determined by the direction of travel of the sensor (Fig. 3-1).

Each edge change from A or B represents a counting step for the period counter (UP/DOWN counter). When Signal A is ahead, the counting state increases, and when Signal B is ahead the count decreases. The controller thus always knows the increment-precise position without having to periodically poll the sensor (real-time capability).

Note, for correct function the A and B signals must be evaluated direction-dependent.

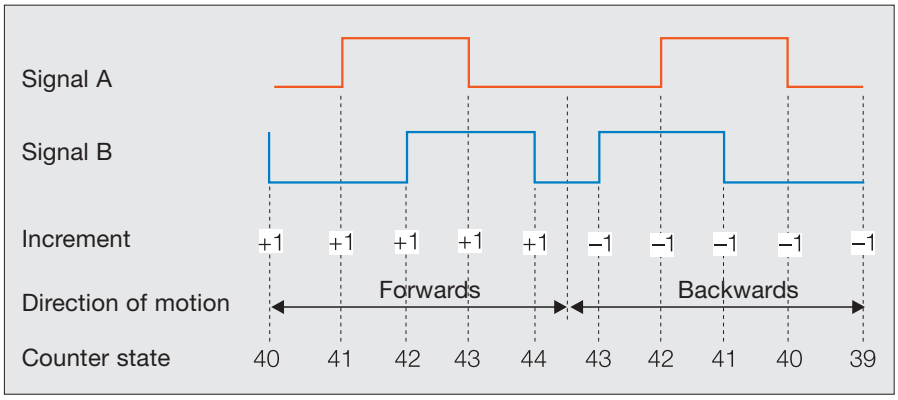


Fig. 3-1: Digitized sinusoidal and cosinusoidal signals with period counter

3.4 Limit switch function

When limit switch functionality is needed, sensing heads can be equipped in addition with a limit switch sensor which senses opposite pole permanent magnets at the ends of the measuring range and sends the signals to the controller (Fig. 3-2).

The limit switch sensors function then even if the rest of the sensor fails (security function).

If the actuation range of the limit switches needs to be longer than their length (20 mm), multiple limit switches of the same type can be mounted in rows.

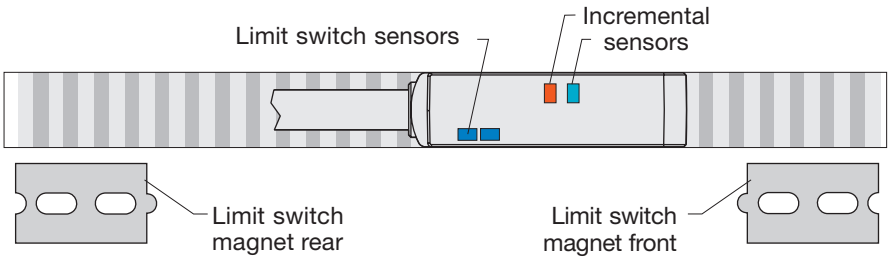


Fig. 3-2: Displacement measurement system with limit switch function

3 Function and characteristics (cont.)

3.5 Reference point function

The reference position is always required as the starting point for the count for each incremental displacement system.
How the reference position is determined depends on the sensor type, the tape and on the controller.

– In the simplest system the sensing head with the sinusoidal and cosinusoidal sensors can count only the magnetic periods. The tape contains only one track with magnetic north and south poles (Fig. 3-3).
In this case the displacement measuring system does not know the absolute position. This is determined by the controller by adding the counted increments. First however the reference position must be determined by a homing move to the reference switch.
– A sensing head with an additional reference point sensor can output a reference point signal as soon as it reaches the magnetically encoded reference point on the second track of the tape (Fig. 3-4). An external reference switch is not needed.
– In another sensing head version a reference point signal is output with each magnetic pole (Fig. 3-3). The signal is repeated every 5 millimeters (pole-periodic).
The tape does not require a second track with a magnetically encoded reference point. In this case a reference switch needs to be used for the selected reference signal.
The controller precisely evaluates the reference position when the switch and the reference point signal of the sensing head are active. Therefore the accuracy requirement for this switch is not especially great.
– The sensor head with an additional reference point sensor can also be combined with a magnetic tape having fixed periodic reference points (Fig. 3-4). Here the reference points are integrated across the entire length of the tape at certain constant intervals, such as every 10 cm.
To determine the exact position, the reference move must cover the entire length of the tape up to the external reference switch.

Advantages of the pole-periodic and fixed periodic tapes:

You can purchase the tape in long lengths and trim it yourself to length.

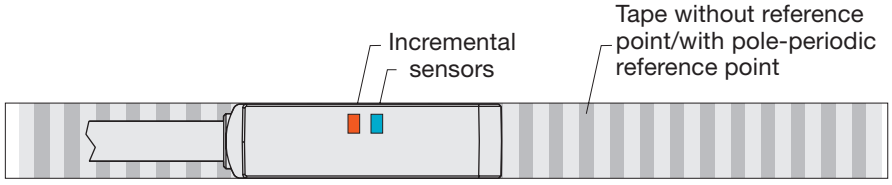


Fig. 3-3: Displacement measurement system with or without pole-periodic reference point

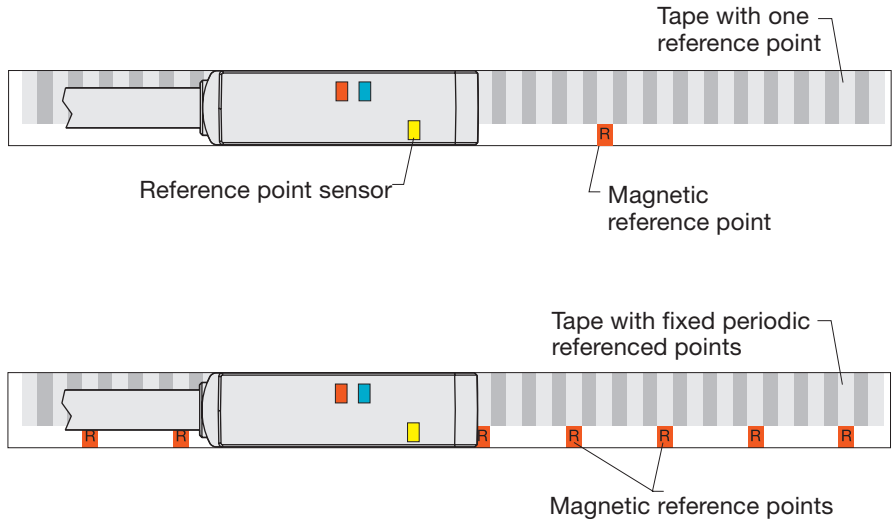


Fig. 3-4: Displacement measurement system with reference point function

4 Installing the Sensor

Important installation notes:

The permissible distance and angle tolerances as per Figs. 4-2, 4-3 and 4-4 must be strictly observed.
The sensing head may not come in contact with the tape at any point along the travel. Contact must still be avoided if the stainless steel cover (optional) is used.

The magnetic tape must not be subjected to strong external magnetic fields. Direct contact with holding solenoids or other permanent magnets must be avoided.

The displacement measurement system must be installed in accordance with the specified enclosure rating.

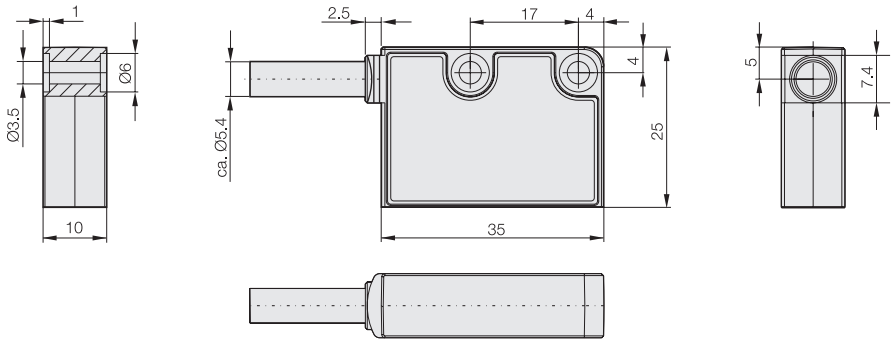


Fig. 4-1: Dimensional drawing

4.1 Distances, tolerances

The following distances and tolerance must be observed when installing the sensing head and tape:

- The distance (air gap) between sensing head and tape as per Fig. 4-2
- The horizontal offset between sensing head and tape as per Fig. 4-3
- The angle tolerances as per Fig. 4-4. Any tilt along the longitudinal axis of the sensing head must still maintain the nominal distance to the tape in the center of the head. The two incremental sensors are located there on the underside.

Note: Even slight tolerance deviations can affect the measuring result.

The specified system accuracy applies only if the tape is installed parallel to the direction of travel.

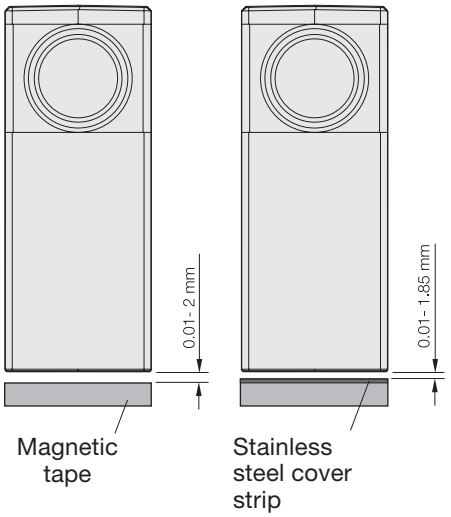


Fig. 4-2: Permissible air gap between sensor head and tape

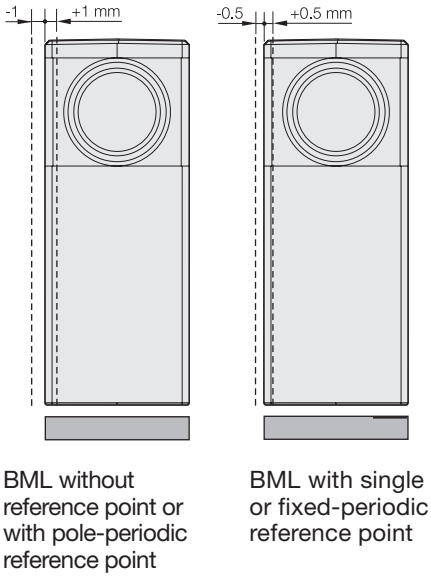


Fig. 4-3: Permissible horizontal tolerance to right or left

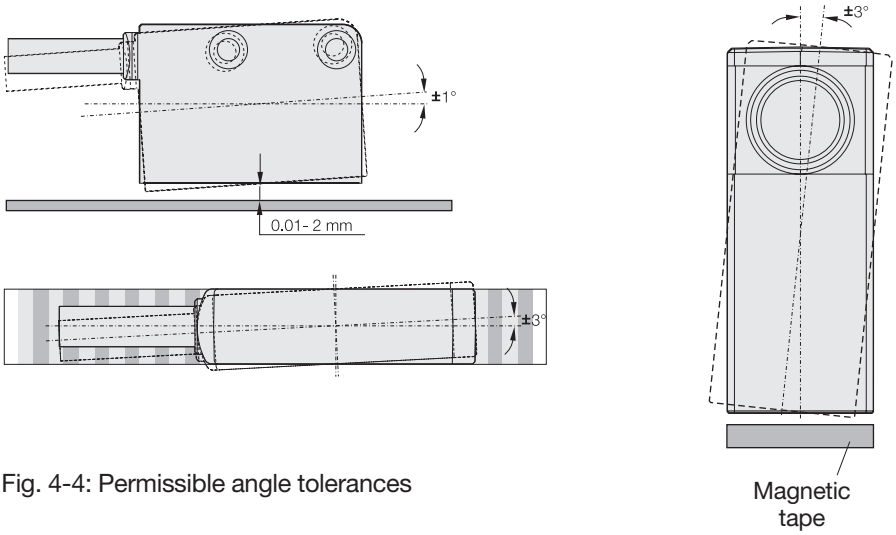


Fig. 4-4: Permissible angle tolerances

4 Installing the Sensor (cont.)

4.2 Determining orientation

The alignments at the front, rear and left are referred to in the installation description and are essential for the correct installation of the sensing head and tape. Starting from the travel direction of the sensing head the orientations are defined in Fig. 4-5.

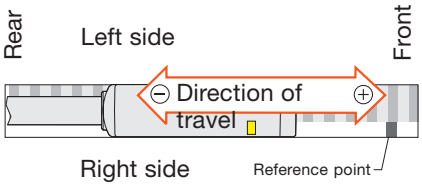


Fig. 4-5: Orientation

4.3 Attaching sensor head

The sensor head should be secured with M3 screws, with its right or left side against the machine part whose position is to be determined.

Important!
No forces allowed on the housing cable. Provide strain relief for the cable.

Recommendation for selecting the tape

BML-S1B: Tape BML-M02-I45
System accuracy ±10 µm

BML-S1E: Tape BML-M02-I46
or magnet rings

> ***Note:***
>
> *For a detailed technical description and installation instructions for tapes, see User's Guide for tape at www.balluff.de*

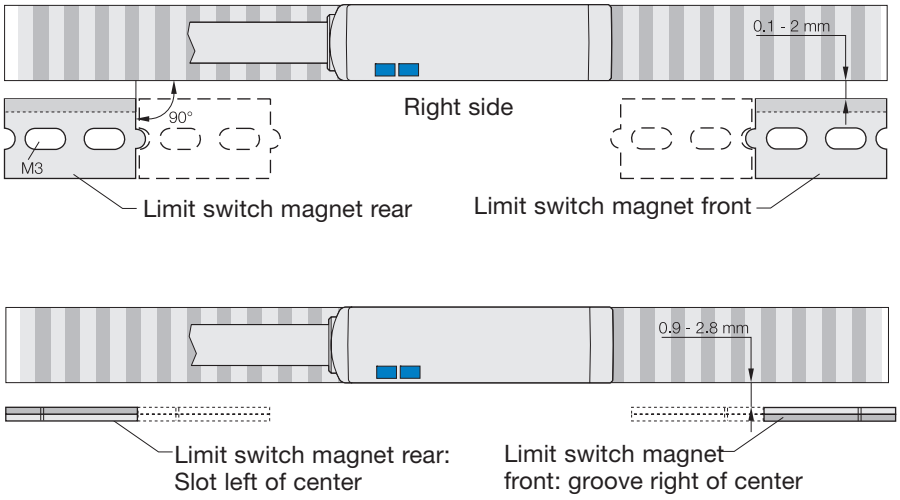


Fig. 4-6: Installing the limit switch magnets

4.5 Installing limit switches

The front and rear limit switch magnets must always be installed on the right side of the sensing head.

When the limit switch is in a housing always attach the front magnet with its nose facing back and the rear magnet with its nose facing front.

When the limit switch is not in a housing, attach the rear magnet with the slot to the left of center and the rear magnet with the slot right of center (Fig. 4-6, 4-8).

The following applies to both limit switch types: If the E-stop travel exceeds the length of the limit switch magnet, multiple magnets may be installed in a row (Fig. 4-7). For ordering information see Section 7.1.

The limit switch sensor becomes active as soon as it begins to enter the magnetic field of the limit switch magnet (Fig. 4-8).

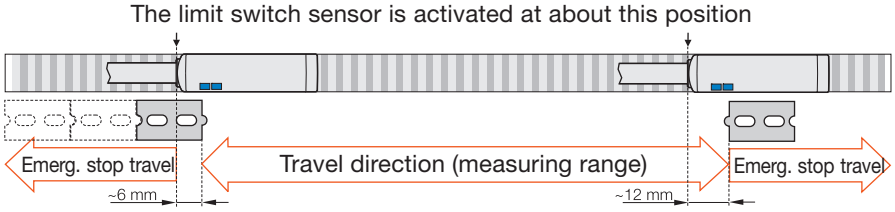

The limit switch sensor is activated at about this position
Emerg. stop travel
~6 mm
Travel direction (measuring range)
~12 mm
Emerg. stop travel

Fig. 4-7: Traverse and emergency stop distances for limit switches with and without housing

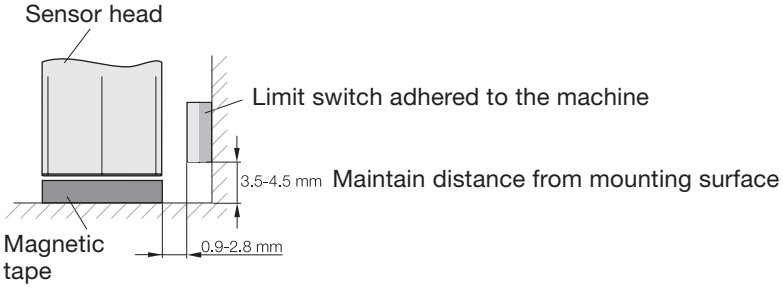


Fig. 4-8: Installation example for limit switch without housing

4 Installing the Sensor (cont.)

4.2 Installing sensor and magnet rings (rotary motion)

Important installation notes:

The permissible distance and angle tolerances as per Figs. 3-5, 3-6 and 3-7 must be strictly observed.
The sensor head must not be allowed to touch the magnet ring.

The magnetic tape must not be subjected to strong external magnetic fields.

Direct contact with holding solenoids or other permanent magnets must be avoided.

The displacement measurement system must be installed in accordance with the specified enclosure rating.

The sensor can be installed with the cable entry to the right or left with respect to the magnet ring (Fig. 4-10).

***Note**:*

For a detailed technical description and installation instructions for magnet rings, see User's Guide at www.balluff.de

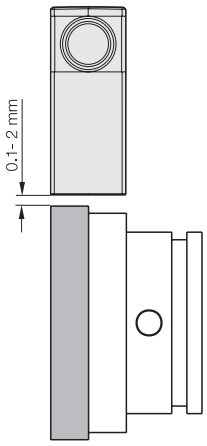


Fig. 4-9: Permissible gap

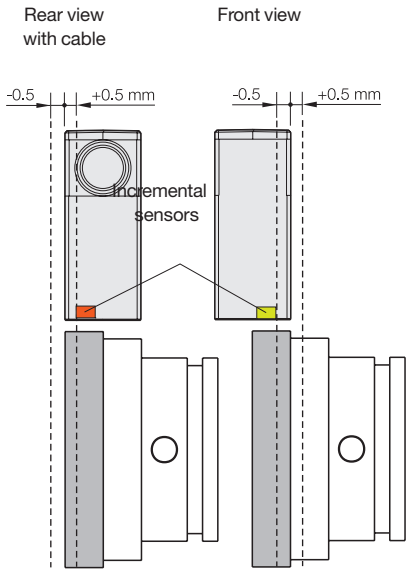


Fig. 4-10: Permissible r axial offset

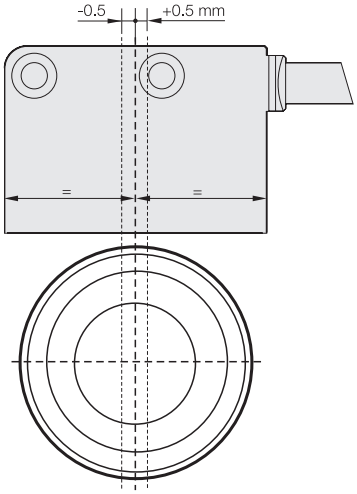


Fig. 4-11: Permissible tangential offset

5 Wiring

Note the following when making electrical connections:

The system and the control cabinet must be at the same ground potential.

To ensure EMC, which Balluff confirms with the CE Marking, the following instructions must be followed.

The cable shield must be grounded on the controller side, i.e., connect to the protection ground.

When routing the cable between the transducer, controller and power supply avoid proximity to high-voltage lines due to noise coupling.
Especially critical are stray coupling caused by AC harmonics (e.g., from phase controls), against which the cable shield offers little protection.

Cable length max. 20 m; conductor cross-section min. 0.14 mm², max. 0.5 mm². Longer cables may be used if their construction, shielding and routing resist external noise fields.
Important:
In spite of a voltage drop in the line a nominal operating voltage of 10 to 30 V or 5 V ±5% must be ensured (see 5.2).

5.1 Cable assignments

12-conductor cable with Sense line (measurement line) for preventing voltage drop in the incoming line.

Cable		Signal
WH	white	A***
BN	brown	/A or n.c.*
GN	green	B***
YE	yellow	/B or n.c.*
GY	gray	Z (Ref. signal)
PK	pink	/Z or n.c.*
BU	blue	GND***
RD	red	+5 V or 24 V***
BK	black	GND Sense
VT	violet	+5/24 V Sense
GYPK	gray/pink	Front limit switch
RDBU	red/blue	Rear limit switch
TR	transp.	Shield 0.34 mm²
BK**	black	Shield 0.34 mm²

** Applies only to BML-S1B0-Q53 and BML-S1E0-Q53. ** Discontinued version.*
**** These wires only for BML-S1B0-Q53_-M400 and BML-S1E0-Q53_-M400.*

5.2 Connecting the Sense line

To avoid voltage drop in the cable, when operating at 5 V a controlled mains adapter with polarity sensing input should be used (Fig. 5-1). If that is not possible or desired, the Sense lines in the 12-conductor cable should be connected parallel to the +5 V and GND line (Fig. 5-2).
When operating at 10...30 V it must only be ensured that the voltage does not fall below 10 V. Such a power supply does not normally possess a Sense line.

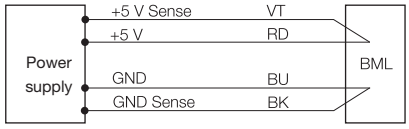


Fig. 5-1: 5 V Power supply with Sense line

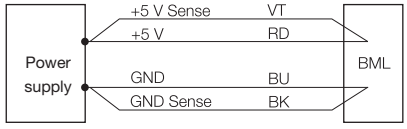


Fig. 5-2: 5 V Power supply without Sense line

Calculating the voltage drop in the line

For the 5 V version of the BML the supply voltage must be 5 V ±5%. The power supply must ensure this voltage and also compensate for the voltage drop in the line. When operating at 10...30 V the voltage must be >10 V.

Use the following formula to calculate the voltage drop in the line:
Vline = R_l x l x [n x 3.1/R_{st} + 0.03] where:

V_{line} = Voltage drop in the line in Volt
R_l = 0.23 for the parallel wiring of the Sense lines with the supply lines (Fig. 5-2)
l = Cable length in m
n = 3, if the reference pulse is processed in the controller
2, if the reference pulse is not processed in the controller
R_{st} = Input impedance of the controller in Ohm

Sample calculation

Under the following conditions:
cable length 5 m
Reference pulse is evaluated
Control input impedance = 120 Ω

Resulting voltage drop is:
V_{line} = 0.23 x 5 x [3 x 3.1/120 + 0.03] = 0.1 V

5 Wiring (cont.)

5.3 Interfaces

Digital incremental system

The sensor transmits the measured variable to the controller as a digital differential voltage signal (RS422) or as an operating voltage signal (HTL).

The edge separation A/B corresponds to the resolution of the sensing head.

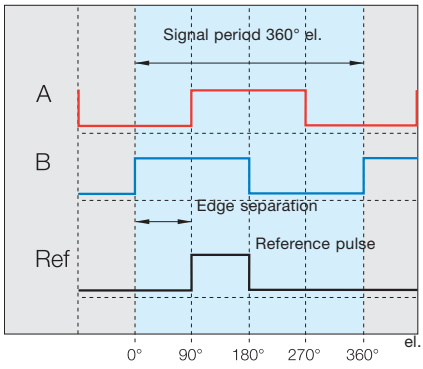
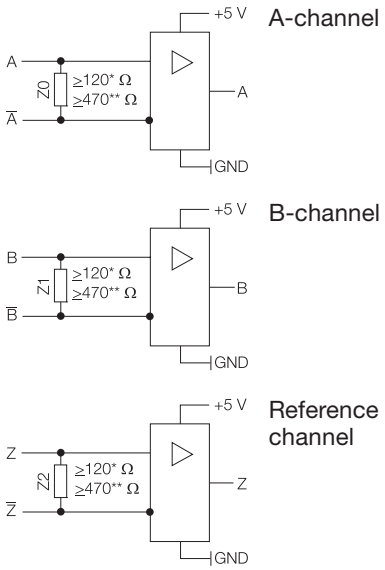


Fig. 5-3: Digital output signals



* only for BML S1B0-Q61...
** only for BML S1B0-Q51...
The 24 V inputs are connected to digital inputs on the controller.

Fig. 5-4: Circuit for following electronics

Circuit for reference position

Depending on the model, the sensor sends either no reference signal, a single reference signal which is magnetically encoded in the tape, or a periodic reference signal (period = 5 mm, width of the reference signal = edge separation, Fig. 5-3). In the latter case an external reference switch must be attached to the desired reference signal.

The accuracy requirements of this switch are not especially high.

Note: The reference signals from the limit switch area are not allowed to be processed.

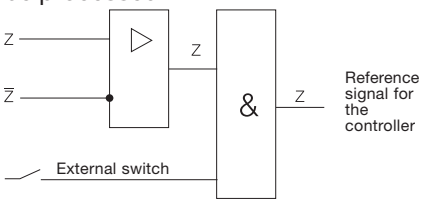


Fig. 5-5: Reference position circuit

Circuit for limit switches front and back

The opposite poled permanent magnets at the ends of the measuring range are each sensed by a limit switch sensor.
The sensor has a normally closed function, so that cable break can be detected.

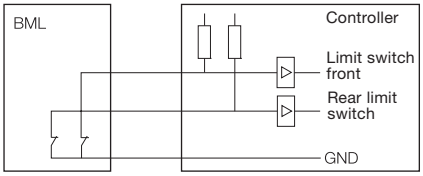


Fig. 5-6: Limit switch circuit

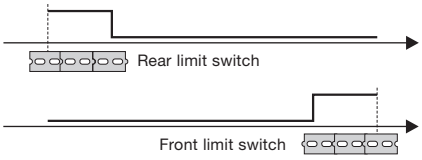


Fig. 5-7: Limit switch signals

Relationship between mechanical resolution and max. frequency

The requirements for your controller (counting frequency) and for the traverse speed of your system can be determined from the BML model used (see part numbering code, p. 18).

Note the values from the following table.

Example for table line 1:
Using a BML with a resolution of 5 µm and a max. speed around 1 m/s ("slow" model) the results are as follows:

- The smallest edge separation which your controller must be able to count is 3.1 µs.

6 Selecting the Appropriate BML and Controller System

Tables 6 -1 and 6 -2 show the relationship between the mech. resolution, the min. edge separation and the max. traverse speed for BML systems using a magnetic tape.

Important!
The controller/display must be able to count the minimum time-based edge separations shown in the tables (note the counting frequency of your controller). The min. edge separation may even be present in the stopped state due to the internal interpolation procedure.

6.1 Standard BML (Tab. 6-1)

Determining the appropriate BML system for an existing controller (linear motion)

Example (see Table 6-1)
Assumptions:

- Your controller can detect a min. edge separation of 1.8 µs. If there is no BML with this min. edge separation, select a BML with greater edge separation.
- The max. traverse speed of the system should be 2 m/s.

Determining the appropriate BML:

- You need a BML with min. edge separation 2 µs (H-type).
- To be able to traverse at max. 2 m/s, select the model with 10 µm resolution (G-type).

With the standard BML the maximum traverse speed depends on the edge separation and on the resolution (see Table 6-1).
In the table the **X** indicates the min. edge separation in time of the BML model and **Y** the mechanical resolution (see part numbering code).

BML - S1A1 - Q61**Y** - M313 - **X**0 - KA05 (model example)

- Edge separation
- Mechanical resolution

Standard BML	Resolution Y: F = 5 µm	G = 10 µm	H = 25 µm	K = 50 µm
Edge sep. X	V_{max} corresponding to edge separation and resolution			
D = 0.12 µs	20 m/s	20 m/s	20 m/s	20 m/s
E = 0,29 µs	10 m/s	20 m/s	20 m/s	20 m/s
F = 0,48 µs	5 m/s	10 m/s	20 m/s	20 m/s
G = 1 µs	3.25 m/s	6.5 m/s	14.75 m/s	14.75 m/s
H = 2 µs	1.5 m/s	3 m/s	7.7 m/s	7.7 m/s
K = 4 µs	0.75 m/s	1.5 m/s	3.95 m/s	3.95 m/s
L = 8 µs	0.375 m/s	0.75 m/s	1.7 m/s	1.7 m/s
N = 16 µs	0.195 m/s	0.395 m/s	0.95 m/s	0.95 m/s
P = 24 µs	0.13 m/s	0.26 m/s	0.65 m/s	0.65 m/s

Table 6-1: Standard BML with defined min. edge separations

Determining the appropriate controller for an existing BML system (linear motion)

What does the max. counting frequency of the controller need to be? The period of the input signal is 4x the edge separation (see Fig. 5-3).
The max. frequency of the input signal is then 1/(4× edge separation).
Example: With an edge separation of 1 µs for the model G BML, the max. frequency of the input signal is 1/4 µs = 250 kHz. The max. counting frequency for 4x evaluation is 1/edge separation = 1/1 µs = 1 MHz.

6.2 BML with predefined traverse speed (predecessor to the standard BML) Linear motion

The requirements for your controller (counting frequency) and for the traverse speed of your system can be determined from the BML model used (see part numbering code). Note the values from following table 6-2.

Example (see Table 6-2, column 2):
For a BML model with 5 µm resolution (F-type) and a max. speed of 1 m/s (type code 1) the following apply:

- The smallest edge separation which your controller must be able to count is 3.1 µs.

In the table **X** indicates the max. traverse speed for the BML model and **Y** the mechanical resolution.

BML - S1A1 - Q61**Y** - M313 - **X**0 - KA05 (model example)

- max. traverse speed (code 1 or 2)
- mech. resolution (For code see Tab. 6-2)

Predecessor BML	Resolution Y: F = 5 µm	G = 10 µm	H = 25 µm	K = 50 µm
V_{max} X	min. possible edge separation			
1 = 1 m/s	3.1 µs	6 µs	15.8 µs	15.8 µs
2 = 10 m/s	0.29 µs	0.58 µs	1.56 µs	1.56 µs

Table 6-2: Predecessor BML with defined max. traverse speeds

6 Selecting the Appropriate BML and Controller System

6.3 Determining resolution and max. rotational speed for BML systems with magnet ring (rotary motion)

Step 1

First decide how many pulses per revolution your application requires. This will be used to select the magnet ring outside diameter, the resolution of the sensor head, and the sensor head model (BML-S1B..., -S1E...).

Table 6-3 shows for each magnet ring the relationship between the number of pulses per revolution and the resolution of the sensor head.

Example (see Table 6-3):

– The application requires 10,000 pulses/revolution.
– These pulses are provided by the BML system, consisting of a sensor head with a resolution of 10 µm (G-type) and a BML.-M2x...031 magnet ring.

Magnet ring type	BML-M2...031/...	BML-M2...048/...	BML-M2...072/...
No. of poles	20	32	46
Resolution Y Sensor head	Pulses per revolution with 4x interpolation		
F = 5 µm	20,000	32,000	46,000
G = 10 µm	10,000	16,000	23,000
H = 25 µm	4,000	6,400	9,200
K = 50 µm	2,000	3,200	4,600

Table 6-3: Pulses/revolution of a BML-S1B... /-S1C... system with magnet rings.

Step 2A (rotational speed is given)

If the **rotational speed is a given for your application**, select (starting with the magnet ring and resolution selected in Step 1) the sensor head with the minimum edge separation which corresponds to the specified pulse count/revolution.

Example:

Assumptions:

– The specified pulse number is 10.000/revolution (see Step 1: BML-M2x...031 ring and BML resolution 10 µm).
– The max. rotational speed should be 5.000 rpm.

Determining the suitable BML sensor head (see Table 6-4)

– Search column "G = 10 µm, 10,000 pulses" for every line whose rotational speed is greater than the required speed.
The sensor head with 0.48 µm edge separation (F-type) is suitable.
Together with magnet ring BML-M2x...031 it meets the system requirements.

Step 2B (controller is given)

If there is a **controller with the min. edge separation**, a max. speed results from a selected resolution (pulses/revolution).

Example

Assumptions:

– Let the min. edge separation be 0.9 µs.

Determining the suitable BML system (see Table 6-4)

– The edge separation is provided by the BML system consisting of a magnet ring BML-M2x...031 and a sensor head with 1 µm edge separation (G-type) and a resolution of 10 µm (G-type). Using this system a max. speed of 3,900 rpm is possible.
If this speed is not sufficient, the number of pulses per revolution (resolution) needs to be reduced, e.g. to 4000 H-type).
Using this system a max. speed of 8,850 rpm is possible.

Tables 6 -4 to 6 -6 show the relationship between the min. edge separation, mechanical resolution and the max. rotational speed for BML systems using magnet rings.

Example:

BML-S1E0-Q53**H**-M413-**K**0-KA05

mech. **resolution Y** (see table for code)

min. **edge separation X** (see Tables 6-4 to 6-6 for codes)

Table 6-4

mech. resolution Y		F = 5 µm	G = 10 µm	H = 25 µm	K = 50 µm
Pulses/revolution		20,000	10,000	4,000	2,000
min. edge separation X	max. kHz A/B-Sig	max. speed for magnet ring BML-M2x...031...			
D = 0.12 µs	2,100	12,000	12,000	12,000	12,000
E = 0.29 µs	860	6,000	12,000	12,000	12,000
F = 0.48 µs	520	3,000	6,000	12,000	12,000
G = 1 µs	250	1,950	3,900	8,850	8,850
H = 2 µs	125	900	1,800	4,620	4,620
K = 4 µs	63	450	900	2,370	2,370
L = 8 µs	32	225	450	1,020	1,020
N = 16 µs	16	117	237	570	570
P = 24 µs	10	78	156	390	390

Table 6-5

mech. resolution Y		F = 5 µm	G = 10 µm	H = 25 µm	K = 50 µm
Pulses/revolution		32,000	16,000	6,400	3,200
min. edge separation X	max. kHz A/B-Sig	max. speed for magnet ring BML-M2x...048...			
D = 0.12 µs	2100	7,500	7,500	7,500	7,500
E = 0.29 µs	860	3,750	7,500	7,500	7,500
F = 0.48 µs	520	1,875	3,750	7,500	7,500
G = 1 µs	250	1,219	2,438	5,531	5,531
H = 2 µs	125	563	1,125	2,888	2,888
K = 4 µs	63	281	563	1,481	1,481
L = 8 µs	32	141	281	638	638
N = 16 µs	16	73	148	356	356
P = 24 µs	10	49	98	244	244

Table 6-6

mech. resolution Y		F = 5 µm	G = 10 µm	H = 25 µm	K = 50 µm
Pulses/revolution		46,000	23,000	9,200	4,600
min. edge separation X	max. kHz A/B-Sig	max. speed for magnet ring BML-M2x...072...			
D = 0.12 µs	2100	5,217	5,217	5,217	5,217
E = 0.29 µs	860	2,609	5,217	5,217	5,217
F = 0.48 µs	520	1,304	2,609	5,217	5,217
G = 1 µs	250	848	1,696	3,848	3,848
H = 2 µs	125	391	783	2,009	2,009
K = 4 µs	63	196	391	1,030	1,030
L = 8 µs	32	98	196	443	443
N = 16 µs	16	51	103	248	248
P = 24 µs	10	34	68	170	170

7 Startup

7.1 Check connections

Caution! The connections are not protected against polarity reversal or short circuit! Before turning on power, check the connections carefully to prevent components from being destroyed by incorrect connections or overvoltage.

7.2 Turn on system

Note that the system may perform uncontrolled movements when it is switched on, in particular when it is switched on for the first time and if the length measurement system in part of a control system for which the parameters have yet to be set. Therefore be sure that no hazards could result from an unpredictable start.

7.3 Check system function

After installing the transducer system or replacing the sensing head, check all functions as follows:

1. Turn on power to the sensor head.
2. Move the sensing head along the entire measuring range.
3. Check whether all signals are output.
4. Check whether the count direction agrees with the direction of travel.
   If not, reverse connections A and /A.

7.4 Regular checking

The functionality of the transducer system and all its associated components should be checked and logged at regular intervals.

7.5 Malfunction

If there is any indication that the transducer system is not functioning properly, remove it from service and secure it against unauthorized use (see also Troubleshooting).

8 Accessories (order separately)

8.1 Limit switch magnets (BML-Z0006)

The magnets can be used with or without housing. The through-holes make it easy to precisely install these limit switch magnets (Fig. 4-8). The housing should be fitted with a magnet only on its side facing the sensor.
The space-saving magnets can be glued or attached using customer-supplied holders. The upper side is marked with a notch.
If the E-stop travel exceeds the length of the limit switch magnet, multiple magnets may be installed in a row (for installation see 4.5).
The scope of delivery includes:
2 magnets with housing
2 magnets without housing, and
1 installation guide

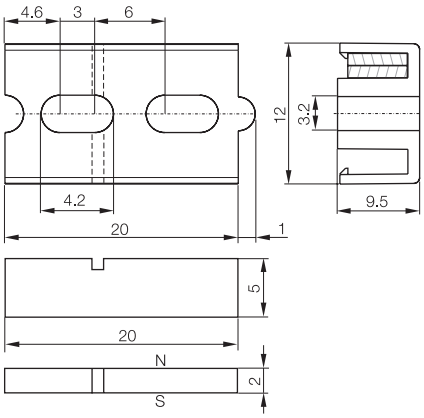


Fig. 8-1: Magnets and housing

8.2 Tape cover

To prevent damage to the tape from things like chips or chemicals, it may be covered with a strip of stainless steel.
Note that the permissible distance between the sensing head and tape is reduced now by the thickness of the cover strip with adhesive film (0.15 mm) (Fig. 4-2).
Before adhering the cover strip, thoroughly clean the surface of the tape (acetone, turpentine, mild plastic cleaner, no gasoline).

Ship configurations:

1 Tape cover and tape can be ordered together in the appropriate length.
2 The tape cover may be ordered in 4 defined lengths.

Note:

For a detailed technical description and installation instructions for magnet rings, see User's Guide at www.balluff.de

9 Troubleshooting

Problem	Possible causes	Remedy/Explanation
The controller is receiving (at times) no distance information.	The necessary supply voltage is not present.	Check whether power is present and whether the BML is properly connected.
	The voltage drop is too great (see formula page 9).	The system must have an operating voltage of 10...30 V or 5 ±5%. Check the voltage on the Sense line or using the formula (p. 9).
	Cables are not connected.	Check cables against the wiring diagrams.
	The orientation of the tape with reference point is not correct.	The reference point mark must be on the right side of the sensor head (Fig. 4-5). Install new tape correctly.
The controller is receiving no distance information at certain points.	The distance between sensor head and tape is (in places) wrong.	Adjust the height of the sensor head. To check, move the head manually over the entire measuring range.
	The magnetic poles of the tape are damaged in places by the presence of strong magnets.	Replace tape.
Position signal is highly noisy	Distance between sensor head and tape is too great.	Attach sensor head closer to tape
Limit switches not switching correctly.	The distance between the limit switch magnets and sensor head is incorrect.	Check and correct distance and angle to tape (Fig. 4-6).
	The limit switch magnets are mounted with the wrong side facing the sensor head (wrong polarity).	Check and correct the limit switch magnets with respect to the travel direction (Fig. 4-7).
Reference point signal not being output.	The orientation of the tape with reference point is not correct.	The reference point mark must be on the right side of the sensor head (Fig. 4-5). Replace tape.
Linearity deviation is out of tolerance.	The sensor head is not moving parallel to the tape (see Fig. 4-4 for tolerance). Distance between sensor head and tape is too great.	Correctly position the sensor head (section 4).

10 Technical Data

Electrical data	**Model BML-S1B0-Q**	**Model BML-S1E0-Q**
Output	Digital RS422 or level same as supply voltage (HTL)	
Output signal	A-Signal, B-Signal, reference signal	
Reference signal by type	No signal, one signal, pole-periodic signal, fixed periodic signal	
Resolution	5 µm, 10 µm, 25 µm, 50 µm	
Output voltage	Differential RS422 signal or same as supply voltage (HTL)	
Limit switch	Vmax = 28 V, I_{max} = 20 mA, N.C.,	GND switching (cable break mon.)
Overall system accuracy Sensor head + tape (see separate guide for magnetic tape)	±50 µm up to 1 mm distance, above that ±60 µm with tape BML-M01-I45	±70...100 µm depending on distance with tape BML-M01-I46
Hysteresis depending on air gap	3 to 7 µm	
max. non-linearity of the processing electronics unidirectional	±30 µm at tape distance <1 mm ±40 µm at tape distance >1 mm	±50 µm at distance <2 mm to tape
Temperature coefficient of overall system like steel	10.5×10^{-6} K^{-1}	
Max. traverse speed	Depending on model, see Table 6-1, 6-2	
Reverse polarity protected	Yes, at 10...30 V	
Overvoltage protected	no	
Operating voltage	5 V ±5% or 10...30 V	
Current draw at 5 V operating voltage	< 50 mA + current draw of the controller (depending on internal resistance)	
Current draw at 10...30 V operating voltage	< 40 mA + current draw of the controller (depending on internal resistance)	
Vibration per IEC 60068-2-27 [1]	100 g/6 ms	
Continuous shock per IEC 60068-2-29 [1]	100 g/2 ms	
Vibration per IEC 60068-2-6 [1]	12 g, 10...2000 Hz	
Ambient conditions		
Operating temperature	–20 °C...80 °C	
Storage temperature	–30 °C...85 °C	
Degree of protection per IEC 60529	IP67	
Mechanical data		
Sensor head to tape gap	0.01...2 mm	
Housing material	PBT	
Connection type	12-conductor cable (LIf12YFCF11Y 6×2×0.08 mm^2)	
Weight	11 g without cable	

[1] Individually determined as per Balluff Factory Standard

10 Technical Data (cont.)

Limit switch magnet BML-Z0006

Dimensions L x W x H	
Magnet housing	20 x 12 x 9.5 mm
Limit switch magnet	20 x 2 x 5 mm

Cable

Type	PU cable:12-conductor, drag chain compatible
Operating temperature	
Flexed	–20...80 °C
Fixed	–40...90 °C
Cable diameter	5.4 ±0.2 mm
Cable bending radius	
Flexed	81 mm
Fixed	41 mm

11 Scope of delivery

Sensor head
Short guide
2 limit switch magnets
(only for BML ...M_ _3...)

11 Versions

Part numbering for sensing head (printed on part label)

BML - S1 B 0 - Q 5 3 G - M 4 1 3 -1 0 - KA05 (example)

Connection:
KA05 = PUR cable 5 m
Possible cable lengths: 2, 5, 10, 15, 20 m

min. edge separation/max. traverse speed:
D = 0.12 µs
E = 0.29 µs
F = 0.48 µs
G = 1 µs
H = 2 µs
K = 4 µs
L = 8 µs
N = 16 µs
P = 24 µs
1 = approx. 1 m/s (discontinued model, cannot be ordered)
2 = approx. 10 m/s (discontinued model, cannot be ordered)

Limit switch
0 = no limit switch
3 = two limit switches

Reference signal
0 = no signal
1 = single signal or fixed periodic
2 = pole-periodic signal

Pole width
4 = 5 mm

Resolution (edge separation A/B)
F = 5 µm
G = 10 µm
H = 25 µm
K = 50 µm

Output voltage
1 = digital square wave signal RS422
3 = level same as supply voltage (only for 10...30 V)

Supply voltage
5 = 24 V (10...30 V)
6 = 5 V

Style
B = Non-linearity of the electronics ±50...±60 µm
E = Non-linearity of the electronics ±100 µm

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